OUTLINES

OF

OPHTHALMOLOGY.

Third Edition.

TO WHICH IS PREFIXED

AN INTRODUCTORY DISCOURSE

ON

THE CAUSES

WHICH HAVE RENDERED

THE EYE

A SEPARATE OBJECT OF MEDICAL STUDY.

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Σὺ δ' ἰατρεῖον ἀνόιγεις, ἄλλο δὲν ἔχων ἢ φάρμακα· ποῖ δὲ ἤ πῶς ἐπιτίθεται ταῦτα μήτε ἰδὼς, μήτε πολυπραγμονήσας.

Ἰδοὺ ἐκεῖνος ταῦτα, κολλύρια κἀγὼ ἔχω.

Μή τι οὖν καὶ τὴν δύναμιν τὴν χρηστικὴν αὐτοῖς; μή τι δὲ ἴδας καὶ πότε καὶ πῶς ὠφελήσει, καὶ τίνας; Τί οὖν κυβεύεις ἐν τοῖς μεγίστοις; τί ῥαδιουργεῖς; τί ἐπιχειρεῖς πράγματι μηδέν σοι προσήκοντι; Ἄφες αὐτὸ τοῖς δυναμένοις, τοῖς κοσμοῦσι.

Epicteti Dissertationes ab Arriano collectæ.

INTRODUCTORY DISCOURSE.*

GENTLEMEN,

IN the few observations which I am now about to offer, by way of introduction to the following course of Lectures, I purpose to direct your attention to the causes which have conspired to render the Eye and its Diseases a separate object of medical study.

These causes, I believe to be chiefly the following four :—

1st. The organ of vision is one of the most complicated in the human frame.

2dly. Its structure and arrangement of parts are in many respects peculiar, its function altogether so, and consequently its diseases different in certain important particulars from those which affect the rest of the body.

3dly. The surgical operations occasionally required for the relief of the diseases of the eye are in minuteness, delicacy and peculiarity accommodated necessarily to the minuteness, delicacy and peculiarity of the parts concerned.

4thly. The diseases of this organ are extremely numerous, and although in many cases purely local, yet they not unfrequently arise in other cases from constitutional affections, or sympathetically from certain morbid conditions of remote organs.

I shall now endeavour to illustrate each of these four propositions.

In the 1st place—The organ of vision is one of the most complicated organs of the body.

* This Discourse was read at the opening of the Course of Lectures on the Eye, in the University of Glasgow, 10th November, 1828.

In fact, under the name "organ of vision" we comprehend a very great number of organs, (organs signifying, as you know, simply *instruments*,) and even some of these taken singly, sufficiently complicated, while all of them contribute more or less essentially to the production of sight.

Different views may be taken of the organ of vision. Ask a physiologist what the organ of vision is, he will probably answer, It is a nerve. The organ of vision is a sensitive nerve, (the expanded termination of which is called the *retina*,) so constituted as to receive certain impressions from light and convey these impressions to the brain ; and to this, the optic nerve, all the rest of the curious and complicated apparatus of the eye may be regarded as subservient.

Ask a natural philosopher, again, the same question, he might perhaps answer in the quaint language of Sir Isaac Newton,* that the eyes are "natural spectacles," referring to the dioptric function of the organ —referring to the lenses of the eye, through which the light passes till it reaches the retina, and by which it is refracted—parts so perfectly analogous to the glasses or lenses of an optical instrument, that they immediately attract the attention of one versant in natural philosophy.

If we take up the organ of vision in an anatomical point of view, we have first of all the eyeball, the greater bulk of which is formed by the lenses, or *humours* as they are termed, of which we have just been speaking, namely, the *vitreous*, *crystalline* and *aqueous humours*, to which we may add the *cornea*, a part which fulfills a double office, namely, that of a lens and that of a tunic. Each of these four parts differs from the others in consistence, and various other particulars. All of them are perfectly transparent, and give passage to the rays of light. The quantity of light, however, which is allowed to penetrate into the eyeball and traverse its lenses, is limited, and in fact measured by a distinct organ, known by the name of the *iris*, an opaque disk, in the centre of which is an aperture, called the *pupil*, which in the living eye is perpetually varying its diameter, according to the intensity of the light to which the eye is exposed. By the lenses, the light entering the eye and passing through the pupil, is changed in its direction, or refracted, so that it is made to converge and come to focal points on the hemispherical nervous membrane, called the *retina*, —formed by the expanded termination of the optic nerve, as just

* Query 31, at the end of the "Opticks."

mentioned—on which is actually formed a minute inverted picture or image of all external objects to which the eye is turned, which image, however, is a mere coincidence, and is no object of our mental perception. It is the direct impression of the refracted and converging rays on the retina, producing there an unknown effect, and communicated by the optic nerve to the brain, hy which the sensations of vision are excited.

Such, then, are the most essential parts of the organ of vision—a pupil or aperture for the transmission of a limited quantity of light, lenses, and a sentient membrane; but that these, the contents of the eyehall, may be supported and kept in their places, nourished with hlood, and furnished with nerves, we find that they are surrounded by certain tunics or spherical membranes, which perform towards them the offices I have now mentioned. These tunics are the *sclerotica* externally, which is continued into the *cornea*, so as to form along with it, a complete hollow sphere or shell; and the capsules of the lenses internally; while immediately within the sclerotica there is spread out a membrane of a dark brown colour, (the *choroid*), for the purpose of ahsorbing the light within the eye, after it has produced its impression on the retina—a membrane, therefore, analogous in its use to the black coating with which the optician lines the tube of a telescope.

The eyeball, thus constructed, must he moved—it must be directed towards the objects to be seen—and having caught the object, it must be fixed upon it, till our examination of it be accomplished. It is therefore supplied with muscles, which turn it in every direction, and thus save us the trouble of moving the whole head, or the whole body—or on the other hand, which fix the eye on the object of our inspection, and fix it so perfectly, that, in many instances, we find the head or the body moving round the eye.

The surface of the eye would become tarnished, were it constantly exposed to the contact of the air, and of the foreign particles which are floating through it unperceived, or driven about hy the wind. Hence the eyelids and lacrymal apparatus—the former closing over the eyehall during sleep, and heing lined by a smooth and slippery mucous membrane, (which is also reflected over the anterior part of the eyeball,) closing upon the eye with instantaneous rapidity many times in a minute, to keep the eye moist and fit for motion, and its transparent surface clear and fit for the transmission of light; while, should it happen that any foreign particle, of greater bulk and more irritation

than common, lights upon the eye, the lacrymal secretion in a sudden flood washes it away. But the mucus which is constantly secreted by the *conjunctiva*, (the membrane which covers the anterior part of the eyeball and lines the eyelids,) and the tears which are thus occasionally called forth, must be removed when they have fulfilled their office, else they would become an impediment and a disease—they would gather on the eye, drop over on the cheek, and make the eye weak and the cheek tender—all which we see actually take place, when the apparatus, by which in the healthy state they are removed, comes to be obstructed. I refer, at present, to the *puncta lacrymalia*, which taking up the mucus and tears, convey them into the *lacrymal canals*, through which they flow into the *lacrymal sac*, and thence descending into the nose, are thus excreted from the seat of their operations.

There are still other contrivances for protecting the eye from injury, from the intrusion of foreign particles, from the intrusion of the sweat descending from the forehead, and from the entrance of too much light; viz.: the *eyelashes* and the *eyebrows*.

All the parts which I have enumerated are connected with, and the most important of them are contained within, an osseous cavity—the *orbit*—which still farther serves for their protection.

Now, even this kind of enumeration were sufficient to make out the assertion, that the organ of vision is one of the most complicated of the body—for neither any of the other organs of sense, nor indeed any part of the body, is composed of so many different members, each fulfilling its own particular duty, but all concurring to one purpose.

There is, however, another view of the complicated structure of the eye, which I think worthy of your attention, and which you might not be so ready to perceive, unless it were pointed out to you. We find in the organ of vision, a minute but distinct specimen of every texture, which exists in the other organs of the body, besides textures *sui generis*.

We have the cellular and adipose textures,—the fibrous,—the cartilaginous,—the osseous,—the nervous,—and muscular, in all their varieties,—bloodvessels,—mucous,—serous,—and synovial membranes, —glands,—skin and hairs; whilst the textures *sui generis*, are the important ones of the cornea, crystalline lens and vitreous humour.

It must be evident to you upon a moment's consideration, that if the organ of vision be so complicated, as these views of its structure shew it to be, the study of it must necessarily be minute and

toilsome—it will be impossible to dismiss the anatomy of the eye and its protecting parts in a few words—it will be impossible to know it after an hour's sitting—but it will require reiterated examinations, many dissections, and careful and attentive study.

The use of investigating the structures of the eye in regard to its component textures, or *histologically*, to use a newly invented term, (a knowledge of textures being now reckoned so important as to constitute a separate science, which is termed *histology**), will appear evident, if you consider that both the functions and the diseases of each of the textures present peculiarities of great importance. For instance, each of them, when it becomes inflamed, manifests certain modifications of the phenomena of inflammation, which modifications are constant, and peculiar to the particular texture affected. Each of them has also a tendency to peculiar diseases. The mucous membranes, for example, when affected with inflammation, pour out a large quantity of puriform fluid from their secreting surfaces, and these surfaces rarely contract morbid adhesions from inflammation. The serous membranes, on the other hand, even on slight inflammation, are apt to effuse coagulable lymph, and their secreting surfaces to adhere together. In treating the diseases of the eye, we are obliged to make constant reference to the peculiar affections of each of the textures. When the conjunctiva, for instance, is affected, we have to do with a part of the mucous system, and to contend with that class of diseases which are called catarrhal or blenorrhœal. When the walls of the aqueous chambers are inflamed, we may expect an event to take place, which must prove particularly dangerous within the eye, namely, an effusion of coagulable lymph, and the formation of morbid adhesions; for it is a portion of the serous system which is then affected. And so on, of all the other parts of the organ of vision.

I now go on to observe, in the 2nd place, that the eye and its diseases have become a separate object of study, because, in many respects, its structure and arrangement of parts are peculiar, and its function altogether so; while its diseases differ, consequently, in certain important particulars, from those which attack the rest of the body.

In illustrating this proposition, I must necessarily confine myself to one or two topics only.

* From ἱστὸς, *tissue*, and λογος, *discourse*.

We have already taken a general view of the structure of the organ of vision, and have seen in what respects it resembles the rest of the body. Whatever kind of texture you find in the rest of the body, you find in this organ—whatever kind of disease you meet with in the rest of the body, you will consequently meet with also in this organ; and the oculist must he a general pathologist, if he means really to understand the diseases of the eye.

But in some particulars, this organ is singular, and unlike to any other part of the body. For example, its transparency is altogether peculiar. Every other part is covered by opaque integuments. The eye alone is intended to admit and transmit the light, aud to modify it during its transmission.

The consequence of its transparency is, that the internal parts of it are exposed to our view in a manner altogether without parallel; that the diseases of these internal parts, (of the iris, for example, and the crystalline lens), are seen in all their progress; and that phenomena which, in other parts of the body we can merely guess at through the opaque integuments, are here actually displayed to our observation. We see the very vessels which are in the state of inflammation—the very capillaries in which there is an impeded flow or an actual stagnation of hlood—we perceive distinctly the augmented size of the ultimate arteries and veins, and the minute ecchymoses arising from their obstructed state—we see the coagulable lymph which is effused—and the adhesions to which that effused lymph gives rise—we see those adhesions and that lymph undergoing a variety of changes from the operations of nature or the influence of our remedies—in one case we see the lymph become organized and filled with new vessels which had no previous existence, in another we observe it gradually diminish, being carried away by the absorbents.

Now, in other parts of the body, the same phenomena which I have just now enumerated no doubt take place, but we rarely or never see them. It often happens that the pleura covering the lungs is bound to the pleura lining the ribs hy effused lymph, exactly as in certain cases of eye-disease, the iris becomes adherent to the crystalline capsule, hut it is only after death, when the scalpel lays open the secret, that we can find our stethoscopic conjectures regarding such a morbid state of the pleura confirmed or refuted. And how often, on inspection after death, do we find adhesions and a variety of other morbid changes in the internal parts of the body, which our skill during the patient's life had never detected, nor even suspected!

It is entirely otherwise with regard to the eye. In some affections of the organ of vision, the seat of disease is no doubt sufficiently hid from inspection; but in the greater number the phenomena are directly submitted to our examination, so that our practice is not regulated by doubtful and obscure signs merely, but by the very changes which are going on before us, and which are the essential steps and processes of the disease.

Pathological anatomy, applied to the other organs of the body, is employed chiefly in displaying lesions, the existence and nature of which were judged of, in a great measure, from what are termed *subjective* or *physiological* signs; symptoms, that is to say, which are received upon the testimony of the patient; but in the eye, where even the internal parts are in a considerable degree exposed to view, and can be still more completely illuminated and displayed by artificial means, a great part of the *anatomical* changes, arising from disease, forms so many *objective* symptoms during life. Hence the morbid anatomy of the eye approaches very much to a symptomatology, as you may see by consulting the excellent work of Mr. Wardrop on that subject—a work which, with many faults, still stands unrivalled in its particular department.

The very question which the oculist has often to settle, is whether the lenses of the eye possess their natural transparency. This is particularly the case with regard to the crystalline lens—and for reasons which your time will not at present permit me to explain, it is often difficult to determine whether that part of the eye is as pellucid as it ought to be, or is more or less affected with opacity. I need scarcely say that from no other study than that of the eye, from no experience in the diseases of other organs, can the oculist derive the slightest assistance in deciding this question. His general pathological knowledge must be of use to him in many of the cases of eye-disease which come before him—such knowledge may enable him to decide on the nature and treatment of inflammation of the conjunctiva, may enable him to detect and to treat with success the Egyptian ophthalmia, for example, although he had never seen the disease before—but to determine on the existence and the seat of *cataract*—to say whether the opacity which is observable behind the pupil is in the crystalline capsule, or in the lens, or in the vitreous humour, or depends upon a change of the retina, or of the choroid coat, no study but a study of the eye, no experience but an experience in eye-diseases, can be of the smallest service.

I might go on to select other illustrations of this proposition. I might shew you, for instance, that the inflammatory diseases of the eye, although they affect tissues which exist on a larger scale in other parts of the body, and may therefore be expected to be similar to the inflammatory diseases of these same textures elsewhere, yet present very remarkable peculiarities;—peculiarities which render the ophthalmiæ by no means so simple and easy a subject as the general practitioner but too frequently imagines. For example, when the iris becomes inflamed, it is no doubt a matter of great interest, that the disease is generally attended by an effusion of coagulable lymph;—but it is still more worthy of consideration, that the symptoms by which the disease is detected are so very peculiar, and often so slight in appearance, as to be apt to be taken for the signs merely of a trivial affection, not worth thinking about, till the pupil is closed and vision extinct:—they bear little resemblance to the symptoms of inflammation in any other part of the body, and can be known only by studying them in the eye itself.

But I proceed to observe in the 3d place, that the eye and its diseases have become a separate object of study, because the surgical operations which are performed on the organ of vision are in minuteness, delicacy and peculiarity necessarily accommodated to the minuteness, delicacy and peculiarity of the parts concerned.

It is a fact worthy of being known to you, that the *internal* parts of the eye are nearly insensible—that the operations which are performed on the crystalline lens particularly are not attended by any pain—that even a large segment of the cornea may be divided with a knife without the patient feeling it—and that the vulgar notions regarding the excessive sensibility of the eye, being altogether derived from the irritation which is excited when a foreign particle lodges beneath the eyelids, are almost quite false when extended to the surgical operations which are performed on the eyeball.

But it is evident that the parts to be operated on are very limited in extent—that the operations themselves are very minute—and when we come to describe these operations, we shall see that they require to be done according to rule, demand a peculiar kind of nicety and dexterity, and are apt to be attended by accidents and dangers which only the most careful foresight can prevent or remedy.

At first view, there appear to be few operations so simple as couching, or displacement of the cataract—entering a needle, that is, through

the coats of the eyeball, and pressing the opaque lens out of sight. Yet, there is perhaps no operation in surgery which, in general, has been so ill performed, and of course so unsuccessful. Not that there is any great difficulty in following the rules laid down for the performance of the operation, but merely because these rules were not known, or not studied as they ought to have been. Till within my own recollection, general practitioners appeared in many cases to make a merit of not studying the eye particularly; they would have it that all our distinctions of eye-diseases, and all our rules for operating on the eye were merely much ado about nothing; and while they persisted in unjustifiable ignorance of the subject, made awkward and mischievous attempts to perform operations which they had never learned.

Vision may be destroyed in attempting to perform the operation of couching, by entering the needle at a wrong place, by giving it a wrong direction, or even by holding it in an improper position; not unfrequently the retina is wounded, or the ciliary processes, or the iris—parts which should altogether be avoided—and sometimes after the early steps of the operation are gone through without any material error, the half-recovered vision of the patient is suddenly and for ever extinguished by pressing down the cataract into contact with, or even through, the frail texture of the retina. Now, all these errors may be escaped by carefully following the rules which have been delivered for the performance of this operation—but then these rules must be studied, understood, and remembered; and as similar rules belong to each of the operations which are performed on the organ of vision, it necessarily follows that the operative surgery of the eye will afford room for an extensive chapter in the science to which we mean to devote our attention in the following lectures.

There are no surgical operations which consist of so many distinct steps as some of those which are performed on the eye. For example, the operation of extraction of the cataract is first of all divided into the three periods of the *section of the cornea*, *the division of the capsule*, and *the exit of the lens*, and each of these three periods is subdivided into several steps or technical manipulations, each of which must be known and observed. These manipulations are extremely minute, and almost totally unlike any of the operative processes which are followed in the surgery of the other parts of the body. An acquaintance with other operations can scarcely in any degree assist us in judging of extraction, or direct us in its performance.

It also necessarily follows, when an operation consists of so many manipulations as that of extraction, that numerous accidents are apt to take place in the course of it—against which the oculist must be constantly prepared—but a knowledge of which he can gain from no general principles of surgery, but from studying the very operation in question, and from actual experience only. In Mr. Ware's work on Cataract, you will find a set of rules for the conducting of the operation of extraction, drawn partly from Wenzel and partly from his own experience, to which he has given the title of "Mementos for the Operator in extracting the Cataract;" and so much persuaded was this experienced operator of the necessity of hearing constantly in mind the rules contained in these mementos, that for many years it was his practice to peruse them on the morning of every day in which he was engaged to perform the operation.

A number of these mementos regard the section of the cornea, which is certainly the nicest operation performed on the body. It is a semicircular incision parallel to the edge of the cornea, and is so completely peculiar that we can compare it to no other surgical operation. We shall hereafter see that this operation requires to be studied, and a certain dexterity acquired by practice on the dead subject, before it is possible to perform it aright.

The operations for the formation of an artificial pupil are also very minute and peculiar—whether they consist in merely making an incision through the iris—or in cutting out a portion of that membrane—or in separating the edge of the iris from its natural connections. One may perfectly understand, too, the different modes of forming an artificial pupil, and yet be ignorant of as important a matter as the mode of operating, namely, the cases which require one of these modes to be selected in preference to the others. The morbid states of the eye which require the formation of an artificial pupil are extremely numerous and varied—and it is necessary not only to choose that kind of operation which is best fitted for the case before us, but in many instances to modify the operation according to the particular condition of the eye.

Now it is evident, that it will be impossible for him to venture upon the decision of questions of this sort, who has not paid considerable attention to the subject, and had opportunities of witnessing the practice of others in cases of the kind.

The 4th and last cause which I mentioned as conducing to render the eye and its diseases a separate object of study was, that the diseases of this organ are extremely numerous, and although in many cases purely local, yet in other cases they arise from constitutional affections, or sympathetically from the affections of remote organs.

On first enunciation, this cause might perhaps seem to you likely to operate exactly in the opposite direction, and to put the treatment of eye-diseases on a level with that of the other diseases of the body. But you must observe that we have already seen how peculiar as well as how complicated the eye is, and how different, in certain respects, its morbid affections and their treatment are from those of the rest of the body. If we add to this, that the eye sympathizes strongly with the rest of the system—derives new diseases from the derangement of other parts—and receives modifications in its ordinary affections from morbid states of the constitution—does this, I would ask, render the diseases of the eye more easy or more difficult to be known? The answer must be, Much more difficult—and hence an additional reason, not indeed for disuniting the study of the eye from the other branches of medicine, but for directing towards it a careful and peculiar attention.

Many of the morbid affections of the eye are of traumatic origin—that is, they arise from mechanical or chemical injuries. Some come under the head of contagious diseases, being the result of the inoculation of the eye with purulent matter. Others are of atmospherical origin—that is, they arise from exposure to extreme degrees or sudden changes of temperature, and especially to streams of cold air. Some diseases of the eye are the consequences of over-exertion in the use of vision—and others arise slowly from causes which we cannot trace, and without any apparent constitutional or sympathetic influence. But by far the greater number of eye-diseases are connected with evident derangement of the constitution or of remote organs.

For instance, 90 cases out of the hundred of inflammatory diseases of the eye in children are scrofulous. Inflammation of the iris is not unfrequently, perhaps most frequently, syphilitic. A considerable number of cases of amaurosis take their origin, not in the eye, but in the sympathetic irritation excited by the diseases of remote organs—such as, the stomach, the bowels, the liver, the kidneys, or the uterus; or arise, not from any local, but from some constitutional cause. Some cases of this disease are connected with plethora—others with exhaustion—while a third set depend on various contaminations of the circu-

lating fluid. And, what gives rise to the chief difficulties attendant on the etiology of this most melancholy disease, not unfrequently in one and the same case, different causes—or even opposite kinds of causes—combine in its production.

Having bestowed a name upon a disease, we are all of us too apt to rest satisfied with noticing its outward and obvious appearances, without attempting the more difficult task of investigating its nature, and tracing back the chain of causation in which it has originated. General practitioners are content with the word *amaurosis*—a loss of vision, which is commonly incurable—and the *mere* oculist goes no farther in the investigation of this frequent disease. Nay, some have scorned all attempts to discriminate its varieties, maintaining, in fact, that amaurosis is always one and the same. A careful examination, however, of the cases of amaurosis which come before you, especially if you have opportunities of studying its pathology on the dead subject, will convince you that its coincident symptoms are very different in different cases—that its seat is by no means uniform—that its origin varies exceedingly—that a few cases, if duly appreciated and correctly treated, are curable, while the greater number are not influenced by any known mode of cure.

Now, how are the curable cases of amaurosis to be discriminated, or how is any progress to be made in a knowledge of the diseases of an organ, so much under the influence of remote causes, except by making the eye and its diseases the subject of a separate study? In general practice—in the practice, for example, of a general hospital—the requisite investigations into the origin of the more obscure diseases of the eye are not, and cannot be, instituted with the necessary care—they would occupy, comparatively, too much time—and hence the necessity which is beginning to be felt in every part of the civilized world, of institutions, where the diseases of the eye, which exist so abundantly among the poor, may be studied, and treated, with that minute and deliberate attention, which they deserve and require.

Such, Gentlemen, are the four causes which appear to have chiefly contributed to render the eye a separate object of medical study—the eye is complicated, it is peculiar, it is minute, while, besides local diseases, it suffers from numerous remote and constitutional influences.

The four causes which we have been considering have operated differently on different minds. The minuteness of the organ and the delicacy of the operations performed in the eye, have tended, no

doubt, to produce the mere mechanical oculist. But it must be evident from the consideration of the other three causes, that it would be impossible to trust the care of any case of eye-disease to one unacquainted with pathology and medicine in general, nor is it difficult to comprehend the only method by which the mind of an individual can be successfully applied to the cultivation of this or any other particular subject in medicine or surgery. He must go upon the principle of concentration, not upon that of subdivision, which however useful in the mere mechanical arts, would here be misplaced, injurious, and contemptible. The multitude of facts which are accurately to be ascertained in medicine is so great, that it becomes necessary for one man to collect them from one part of the economy, and for another observer to attend chiefly to another part. But each of these observers must possess certain lights to throw upon the object of his research—that object will never become illuminated merely by his looking at it—he must know what has already been observed—he must know the principles already deduced—he must come to his own station not to make more re-observations of what is already known, but to discover what is yet unknown—he must communicate to the other observers the results of his experience and learn the results of theirs.

This, then, is the mode in which the study of the eye and its diseases ought to be pursued, not only by those who mean to make this the chief object of their professional labours—but by those who intend to enter the medical service of their country, where a knowledge of the diseases of the eye will not only form a high recommendation, but be absolutely required—and even by the general practitioner, who, situated often at a distance from the assistance of others, must depend in eye-diseases, as in all other cases, on his own resources, and will find it no slight reproach, when eye-cases are brought to him, either to be obliged to confess that this is a part of his profession he has never studied, or, recklessly attempting to treat what he does not understand, blunder on till he probably finds his patient deprived of sight.

The great secret in treating eye-cases—the secret without which everything else must fail—is to know and discriminate the various states of disease to which the eye is subject. The successful removal of eye-diseases depends almost entirely on accurate diagnosis. Discover what the disease is—make out accurately the pathology of the

case before you—make out the *rationale* of the symptoms, local and general—and if the case be curable, the cure is generally simple. Confound many different diseases—huddle them promiscuously together under a few general and perhaps unmeaning terms—and to a certainty you will mistreat some of them.

Another point on which success in this department of medical practice very much depends, is the doing of whatever is done to the very best of one's ability—doing nothing slovenly, nothing carelessly, nothing at random,—prescribing no remedy without a clear and reasonable object in view—applying every remedy with the utmost care—and watching the effects of every application with a diligence equal to that with which the chemist watches the effects of his re-agents, and with an eager hope of discovering something new and useful.

I trust that those who mean to follow me through this course of lectures, enter on the subject with that love of truth, which renders them, in all their pursuits, impatient to be put upon the track most likely to lead to the successful investigation of nature—with that candour which enables the inquirer, without the least hesitation, to renounce opinions hastily formed, for others, the results of maturer examination—with that love of humanity which grudges no labour likely to contribute to so noble an object as the advancement of the healing art.

To those who are imbued with these principles, the study of the eye and its diseases is calculated to afford a high degree of interest and satisfaction. Its anatomical structure, above that of every other organ of the body, abounds in the display of means exquisitely adapted to ends—the questions which the physiology of vision embraces carry the inquirer into those branches of philosophy which are not less distinguished for their sublimity than their truth—and as for the practical part (which also must be the principal part) of our subject, believe me, you will not merely understand vastly better the nature and treatment of all other diseases by studying those of the eye—you will not merely acquire thereby an aptitude for patient and laborious inquiry, habits of method and arrangement, and a spirit of accuracy which you will carry with you into all your pursuits—but by this study you will be preparing yourselves for reaping, in after-life, a harvest of as generous emotions as can affect the human heart. I know no feeling more enviable—I believe there is no feeling more capable

of filling the mind with pleasure—than that which a medical practitioner must experience, when, beholding the delighted and grateful subject of his art, he can indulge the consciousness of having been the means, however humble, of saving or of restoring sight—of conferring, therefore, on a fellow-creature a boon, nearest in excellence to those which man receives from the Creator.

OUTLINES

OF

OPHTHALMOLOGY.

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INTRODUCTION.

1. OPHTHALMOLOGY, (from ὀφθαλμὸς, *eye*, and λόγος, *discourse*), that branch of medical science which treats of the structure, functions, and diseases of the organ of vision.

2. Progress of Ophthalmology—Its ancient compared with its modern state—Illustrations—from lacrymal organs and their diseases—anatomy of the tunics of the eye, and the ophthalmiæ—functions and diseases of the crystalline body—invention of artificial pupil—A complete history of the science desirable, so as to display the gradual advance in the knowledge of the anatomy, physiology, and pathology of the eye.

3. Functions of animals threefold; viz., generative, nutritive, relative—Sketch of the nervous system and organs of sensation, throughout the four grand divisions of the animal kingdom.

CLASSIFICATION OF THE ANIMAL KINGDOM.

First Grand Division.—VERTEBRATA.—4 Classes. 32 Orders.

Class I. Mammalia. 13 Orders.	Bimana,	*Man.*
	Quadrumana,	*Monkey, ape, lemur.*
	Cheiroptera,	*Bat.*
	Insectivora,	*Hedgehog, mole.*
	Carnivora,	*Bear, dog, cat, seal.*
	Marsupialia,	*Kangaroo.*
	Rodentia,	*Rat, hare.*
	Edentata,	*Sloth, ant-eater.*
	Monotremata,	*Ornithorynchus.*
	Pachydermata,	*Elephant, hog, rhinoceros.*
	Solipeda,	*Horse.*
	Ruminantia,	*Camel, ox, sheep.*
	Cetacea,	*Porpoise, whale, dugong.*
Class II. Aves. 6 Orders.	Accipitres,	*Eagle, owl.*
	Passeres,	*Lark, thrush, linnet, swallow.*
	Scansores,	*Parrot, crow, wood-pecker.*
	Gallinæ,	*Peacock, turkey, pheasant, dove.*
	Grallæ,	*Ostrich, flamingo, crane, snipe, rail.*
	Palmipedes,	*Swan, goose, petrel, pelican, gull.*
Class III. Reptilia. 4 Orders.	Chelonia,	*Tortoise, turtle.*
	Sauria,	*Lizard, crocodile.*
	Ophidia,	*Snake, boa.*
	Batrachia, (*Amphibia*)	*Frog, salamander, proteus.*
Class IV. Pisces. 9 Orders.	* *Skeleton osseous.*	
	Acanthopterygii,	*Perch, mullet, mackerel, blenny.*
	Malacopterygii abdominales,	*Carp, tench, loche, pike, silurus, salmon, herring.*
	Malacopterygii subbranchiani,	*Cod, flounder, lump-fish.*
	Malacopterygii apodes,	*Eel, gymnotes.*
	Lophobranchiani,	*Pipe-fish.*
	Plectognathi,	*Diodon, sun-fish.*
	* * *Skeleton cartilaginous.*	
	Sturionii,	*Sturgeon.*
	Selacii,	*Shark, ray, torpedo.*
	Cyclostomi,	*Lamprey.*

SECOND GRAND DIVISION.—MOLLUSCA.—7 CLASSES. 15 ORDERS.

Class I. 1 Order.	Cephalopoda,	- -	*Cuttle-fish, nautilus.*
Class II. 1 Order.	Pteropoda,	- -	*Clio.*
Class III. GASTEROPODA. 9 Orders.	Pulmonata,	- -	*Slug.*
	Nudibranchiata,	-	*Doris.*
	Inferobranchiata,	-	*Phyllidia.*
	Tectibranchiata,	-	*Aplysia.*
	Heteropoda,	- -	*Carimaria.*
	Pectinibranchiata,	-	*Welk, murex.*
	Tubulibranchiata,	-	*Vermetus.*
	Scutibranchiata,	-	*Halyotis.*
	Cyclobranchiata,	-	*Limpet.*
Class IV. 1 Order.	Conchifera,	- -	*Oyster, mussel, tridachne, teredo.*
Class V. 1 Order.	Brachiopoda,	- -	*Lingula, terebratula.*
Class VI. 1 Order.	Tunicata,	- -	*Ascidia, pyrosoma.*
Class VII. 1 Order.	Bryozoa,	- -	*Plumatella, flustra.*

THIRD GRAND DIVISION.—ARTICULATA.—7 CLASSES. 30 ORDERS.

Class I. CRUSTACEA. 8 Orders.	* *Malacostraca.*		
	Decapoda,	- -	*Crab, lobster.*
	Stomapoda,	- -	*Squilla.*
	Amphipoda,	- -	*Sandhopper.*
	Læmodipoda,	- -	*Cyamus.*
	Isopoda,	- -	*Woodlouse.*
	* * *Entomostraca.*		
	Branchiopoda,	-	*Monoculus.*
	Pœcilopoda,	- -	*Limulus, argulus.*
	Epizoa,	- -	*Lernœa.*
Class II. 1 Order.	Cirrhopoda,	- -	*Balanus, barnacle.* †
Class III. ARACHNIDA. 2 Orders.	Pulmonariæ,	- -	*Spider, tarantula, scorpion.*
	Trachearіæ,	- -	*Phalangium, mite.*
Class IV. 1 Order.	Myriapoda,	- -	*Iulus, scolopendra.*
Class V. INSECTA. 11 Orders.	Thysanoura,	- -	*Lepisma, podura.*
	Parasita,	- -	*Louse, tick.*
	Suctoria,	- -	*Flea.*
	Coleoptera,	- -	*Beetle, glow-worm, meloe, coccinella.*
	Orthoptera,	- -	*Ear-wig, cock-roach, grass-hopper.*
	Hemiptera,	- -	*Bug, cuckoo-spit, aphis.*
	Neuroptera,	- -	*Dragon-fly, ephemera, lion-ant, termes.*
	Hymenoptera,	-	*Ant, wasp, bee.*
	Lepidoptera,	- -	*Butterfly, hawkmoth, moth, bombyx.*
	Rhipiptera,	- -	*Xenos, stylops.*
	Diptera,	- -	*Midge, house-fly, horse-fly, œstrus.*
Class VI. ANNELIDA. 4 Orders.	Abranchiata,	- -	*Nais, gorduis.*
	Tubicola,	- -	*Serpula, amphitrite.*
	Dorsibranchiata,	-	*Arenicola, nereis.*
	Pulmonata,	- -	*Leech, earth-worm.*
Class VII. ENTOZOA. 3 Orders.	Nematoidea,	- -	*Ascaris lumbricoides.*
	Cestoidea,	- -	*Cysticercus, tœnia.*
	Trematoda,	- -	*Distoma.*

† Cuvier placed the cirrhopoda amongst the mollusca, to which in external form they bear a strong resemblance; but the structure of their nervous system, the segmental division and bilateral symmetry of their bodies, and the history of their development, determine their articulated character.

FOURTH GRAND DIVISION.—RADIATA.—5 CLASSES. 7 ORDERS.

Class I. 1 Order.	Echinodermata,	-	*Asteria, echinus, holothuria.*
Class II. 1 Order.	Rotifera,	- -	*Rotifer, notommata.*
Class III. 1 Order.	Acalephæ, (*Sea-nettles*),		*Medusa, rhizostoma, physalus.*
Class IV. 1 Order.	Zoophyta, (*Polypi*)		*Alcyonium, actinia, beroe, hydra, sertularia, madrepores, corals.**
Class V. PROTOZOA. 3 Orders.	Rhyzopoda,	-	*Actinophrys, amœba.*
	Infusoria,	- -	*Chilodon, vorticella.*†
	Porifera,	- -	*Sponges.*

Nervous matter, gray and white—the gray consisting of nucleated cells, the white of nervous filaments—general theory of the functions of the gray and white nervous matter—two great divisions of nervous system, the *cerebro-spinal* and the *visceral*—connexions of the great sympathetic or visceral nerves with the spinal nerves—Bell's system

* Some polypi (the hydroid) give off medusa-buds, which are developed into medusæ, and these produce eggs from which new polypi are generated. Some medusæ, if not all, thus appear to be merely different phases of the same polymorphous animal-system, the medusæ being the fully developed form. In some cases, the medusa-buds do not become detached.

† Were what are called *spermatozoa* independent animals, they would here be admitted as an order; but they are merely living elements of the semen, so organised as to excite the development of the germ in the female, and are analogous to the moving molecules, called *phytosperms*, which exist in plants.

of respiratory nerves—organs of sense in vertebrata—one uniform type observed in the structure of the eye, in this grand division—nervous system of mollusca, contained within an envelope common to it and to the viscera—nervous collar round œsophagus, a characteristic of all invertebrata—organs of sensation in the mollusca—eyes of gasteropoda—of cephalopoda—cerebral ganglion and chain of ganglia of articulata—organs of sensation in articulata—eyes of some crustacea mounted on pedicles—agglomerated eyes of entomostraca—simple eyes of arachnida—simple and compound eyes of insecta—structure of compound eyes—difficulties regarding their function—eyes of echinodermata—organs of hearing in acalephæ mistaken for organs of sight—no definite traces of nervous system in zoophyta nor protozoa.

4. Physiological estimate of the senses—touch, taste, smell, hearing, sight—Differences in their degree and kind of sensibility—All of them connected with muscular movements, which serve to protect the organ of sense from injury, to bring it into the position best fitted for use, and to increase its sentient power.

5. Symmetry of organs of vision—their tendency to symmetrical diseases.

PART FIRST.

PARTS PROTECTING THE EYEBALL.—*(Tutamina Oculi).*

The tutamina oculi consist of the orbit and periorbita, eyebrow and eyelids, tunica conjunctiva, secreting and excreting lacrymal apparatus, muscles of the eyelids and eyeball, fibro-cellular capsule of the eye, and orbital arcolar and adipose substance.

SECTION I.—ORBIT AND PERIORBITA.

Structure.—Place of orbit—form—component bones—each orbit formed by seven bones, the two orbits by eleven—sutures—parietes—base—apex—fossa lacrymalis—fossa trochlearis—communications by foramina and fissures—nerves and vessels passing through these—attachments of muscles—periosteum—orbit nourished through the medium of Schneiderian membrane, dura mater and periorbita—bloodvessels—contents of orbit, as displayed in vertical and horizontal sections—relations to neighbouring cavities, *viz.* nostrils, frontal sinus,

maxillary sinus, sphenoid sinus, cranium—national and individual differences—If cranium a gigantic vertebra, or a collection of vertebræ, what part of this vertebra or collection of vertebræ, does the orbit occupy?

Functions.—Forms osseous capsule for eye—gives origin to muscles for moving eye and eyelids—affords entrance to arteries and nerves, and exit to veins.

Comparative anatomy.—Importance of comparative osteology—changes in the place, form, relations, and composition of the orbit, in different classes of animals—orbit in quadrumana—carnivora—rodentia—edentata—pachydermata—solidungula—ruminantia—cetacea—orbit in birds—reptiles—fishes.

Diseases.—1. Injuries of the orbit—contusions over its edge—fractures of its edge—fractures of its walls, attending fractured skull, and fractured bones of the face—orbit fractured by a blow on the eye?—counter-fracture of the orbit—penetrating wounds of the walls of the orbit—incised wounds of the orbit—gunsbot wounds of the orbit—2. Periostitis, ostitis, caries, necrosis of the orbit—3. Periostosis, hyperostosis, exostosis, osteo-sarcoma of the orbit—cysts in its parietes—4. Dilatation, deformation, and absorption of the orbit by pressure from within the orbit—from the nostril—from the frontal sinus—from the maxillary sinus—from the sphenoid sinus—from the cavity of the cranium.

SECTION II.—SECRETING LACRYMAL ORGANS.

Structure.—1. Fossa lacrymalis—2. Lacrymal gland—superior and inferior portions of it, or glandula innominata Galeni and glandulæ congregatæ—form of lacrymal gland—size—relations—3. Ducts of lacrymal gland—their discovery by Steno—perforate conjunctiva—4. Lacrymal artery—general account of ophthalmic artery—5. Lacrymal veins—general account of ophthalmic veins—6. Lacrymal nerves—general account of 5th nerve—distribution of ophthalmic division—two branches of lacrymal nerve—communication of external branch with 2d and 3d divisions of 5th nerve—nervous connexions of lacrymal gland with conjunctiva and orbicularis palpebrarum.

Functions.—Composition of tears—quantity—only an occasional secretion—wash away mucus and foreign particles—connexion of lacrymal discharge with passions of the mind.

Comparative Anatomy.—Lacrymal gland not to be confounded with glandula Harderi—lacrymal gland in mammalia—birds—reptiles—elephant has no nasal duct, puncta, lacrymal sac or lacrymal gland—no nasal duct in morse—mechanism of lacrymal secretion in serpents—no lacrymal gland in amphibia or frog tribe—nor in fishes.

Diseases.—1. Injuries of lacrymal gland and ducts—2. Lacrymal xeroma—3. Epiphora—4. Inflammation and suppuration of glandulæ congregatæ—of proper lacrymal gland—5. Chronic and specific enlargements of lacrymal gland—hypertrophy of glandulæ congregatæ—hypertrophy, chloroma, scirrhus, and medullary fungus of lacrymal gland—6. Encysted tumour in lacrymal gland—7. Encysted tumours in the vicinity of glandulæ congregatæ and lacrymal ducts—8. True lacrymal fistula—9. Morbid tears—10. Sanguineous lacrymation—hæmorrhage from lacrymal gland—11. Dacryoliths or lacrymal calculi in lacrymal ducts.

SECTION III.—EYEBROW AND EYELIDS.

Structure.—1. Integuments—2. Areolar tissue of eyelids—destitute of fat—3. Eyebrow—4. Fissura palpebrarum—5. Internal and external canthus—6. Cilia—structure of hair bulbs—7. Ciliary glands.—8. Orbicularis palpebrarum—9. Epicranius—10. Corrugator supercilii—11. Fibrous layer of eyelids—12. Levator palpebræ superioris—13. Internal and external palpebral ligament—14. Fibro-cartilages or tarsi—15. Meibomian follicles—their ducts—apertures of ducts, in the skin, not in the conjunctiva—16. Edges of eyelids—17. Conjunctiva—18. Arteries of eyelids—19. Veins of eyelids—20. Nerves of sensibility, from 5th nerve—21. Nerves of motion, to orbicularis palpebrarum, epicranius, and corrugator supercilii, from portio dura or facial nerve—origin, course and distribution of facial nerve—22. Branch of motor oculi or 3d nerve, to levator palpebræ superioris—general account of 3d nerve.

Functions.—1. Give mechanical support to eyeball—increased during certain forced acts of expiration, as in coughing, sneezing, &c. when flash observed from pressure of orbicularis—2. Serve as organs of touch—reflex action of eyelids, through the medium of 5th nerve and facial nerve—exclude and extrude foreign substances—vertical movements of upper eyelid—horizontal movement in which both eyelids partake, especially lower eyelid—convey tears and mucus towards

puncta—effect of Meibomian secretion—use of eyebrow in turning aside sweat from brow—3. Keep cornea moist and clear—prevent its drying during sleep—motion of eyeball upwards as eyelids close—4. Moderate or exclude ligbt—5. Keep eye warm—complaint of cold being felt in the eye, wben orbicularis palsied—6. Are organs of expression, especially tbrough epicranius and corrugator.

Comparative Anatomy.—Eyelids of quadrupeds—rein-deer—ornithoryncbus—cetacea—eyelids of birds—reptiles—serpents and fishes described as having an imperforate transparent eyelid—eyelids of tetrodon mola—eyelids wanting in fisbes generally and in most of the lower classes of animals—retraction of the eye into the sbeath of its tubular peduncle in some gasteropoda.

Diseases.—1. Injuries of eyebrow and eyelids—contusion and eccbymosis—incised and lacerated wounds—coloboma—burns and scalds—poisoned wounds—2. Phlegmonous inflammation—3. Erysipelatous inflammation—4. Phlebitis—5. Carbuncle—6. Malignant pustule—7. Sypbilis—syphilitic ulceration—syphilitic eruptions affecting tbe eyelids of infants—8. Scirrbus and cancer—9. Ophthalmia tarsi, or inflammation of the edges of the eyelids—10. Porrigo larvalis affecting eyelids—11. Vitiligo—12. Abscess of Meibomian follicles—13. Obstruction of Meibomian apertures—14. Meibomian calculus—15. Hordeolum—16. Phlyctenula and milium—17. Warts—18. Tumours—chalazion or fibrinous tumour—molluscum or albuminous tumour—encysted tumour—fibro-plastic or sarcomatous tumour—neuroma—elephantiasis—fungus baematodes—melanosis—19. Tylosis, or callosity of eyelids—scrofulous—arthritic—20. Nævus maternus—aneurism by anastomosis—21. Œdema—22. Emphysema—23. Lagophthalmos—24. Ectropium—from acute inflammation and strangulation—from chronic inflammation and excoriation—from a cicatrice—from caries of orbit—25. Trichiasis and distichiasis—26. Entropium—acute—chronic—[27. Anchyloblepbaron—See Part II. Section XIX.]—28. Madarosis—[29. Neuralgia of 5tb nerve, or tic douloureux—hemicrania—30. Anæsthesia of parts supplied by 5th nerve—See Part II. Section LI.]—31. Twitching or quivering of orbicularis palpebrarum—32. Morbid nictitation—33. Blepharospasmus and photophobia—34. Facial palsy, affecting orbicularis palpebrarum and muscles of eyebrow—35. Ptosis—from hypertrophy—congenital—traumatic—atonic—paralytic—36. Phtheiriasis.

SECTION IV.—TUNICA CONJUNCTIVA, SEMILUNAR MEMBRANE, AND CARUNCULA LACRYMALIS.

Structure.—1. Membranes of the body, secreting and non-secreting —tegumentary membrane and sanguiferous membrane—their vast extent—skin and mucous membrane—general structure of tegumentary membrane—its three layers—gastro-pulmonary and genito-urinary mucous membranes—two surfaces of mucous membranes—the adherent, turned generally towards muscles—the free, villous or papillous —diversities of villi or papillæ in different parts of mucous system—different varieties of epithelium—mucus—its chemical composition—pathology of mucous membranes—2. Tunica conjunctiva, a mucocutaneous membrane, conjoining eyelids and eyeball—corpus papillare, rete mucosum, and epithelium of conjunctiva—3. Conjunctiva palpebrarum—conjunctiva bulbi—two sinuses of conjunctiva—two surfaces of conjunctiva—loose connection by areolar tissue between conjunctiva and sclerotica—conjunctiva bulbi destitute of papillæ—4. Semilunar membrane—analogue of membrana nictitans of quadrupeds, and third eyelid of birds—5. Caruncula lacrymalis—a congeries of sebaceous glands—its ducts—its cilia—6. Nature of conjunctiva—proofs of its partaking of the properties of skin—proofs of its being a mucous membrane—two classes of conjunctivitides or inflammations of the conjunctiva, namely, puro-mucous and eruptive—sequelæ of inflammations of conjunctiva, as, chemosis, granular conjunctiva, xeroma, symblepharon, illustrative of its nature—7. Epithelium of conjunctiva prolonged over cornea—coagulates on eye being thrown into boiling water—8. Arteries of conjunctiva, derived from two sources—the superficial or palpebral, from the superior and inferior palpebral arteries and the lacrymal; the deep-seated or ocular, from the oculo-muscular and anterior ciliary arteries—two net-works formed by these arteries, the superficial or conjunctival, and the deep-seated or sclerotic—vascular wreath round edge of cornea, formed by the anastomosis of the two net-works—9. Veins of conjunctiva—10. Nerves of conjunctiva, from different branches of 5th nerve.

Functions.—Conjunctiva, by its lubricating secretion, favours motions of eyeball and eyelids—keeps cornea moist and transparent —semilunar membrane directs tears and mucus into puncta—caruncula supplies deficiency of Meibomian follicles at inner canthus.

Comparative Anatomy.—1. Membrana nictitans of quadrupeds—its cartilaginous stalk—means by which it is moved over eyeball—2. Third eyelid of birds—its two muscles, triangularis and quadratus—their nerves from abducens or 6th nerve—3. Third eyelid of reptiles—4. Gland of Harder—in quadrupeds—in birds—5. Conjunctiva not cast with skin by serpents—merely the epidermis of the imperforate eyelid cast—6. Vascularity of conjunctiva in horse, in health and disease.

Diseases.—1. Foreign substances adhering to conjunctiva—2. Dacryoliths, or lacrymal calculi, in sinuses of conjunctiva—3. Injuries of conjunctiva—mechanical—chemical—symblepharon from action of sulphuric acid—staining from nitrate of silver—burns of conjunctiva—4. Subconjunctival ecchymosis—5. Subconjunctival emphysema—6. Subconjunctival phlegmon—7. Subconjunctival œdema—8. Pterygium—tenue—crassum—9. Pinguecula—10. Conjunctival warts—11. Conjunctival polypus—12. Nævus maternus of the conjunctiva—13. Fungus of the conjunctiva—14. Scirrhus and cancer of the conjunctiva—15. Conjunctival and subconjunctival tumours—tricosis—vesicular tumours—adipose, sarcomatous, cartilaginous tumours—albuminous tumour or molluscum—16. Melanosis of the conjunctiva—17. Inflammation of semilunar membrane and caruncula lacrymalis—18. Polypus of caruncula—19. Encanthis—benigna—maligna—20. Lithiasis of caruncula.

SECTION V.—EXCRETING LACRYMAL ORGANS.

Structure.—1. Lacrymal groove and osseous nasal duct—three component bones—2. Lacus lacrymarum—3. Papillæ lacrymales—4. Puncta lacrymalia—5. Canaliculi, or lacrymal canals—6. Lacrymal sac—7. Nasal duct—8. Mucous lining membrane, covered by ciliary epithelium—9. Orbicularis palpebrarum—10. Musculus sacci of Duverney, or tensor tarsi of Horner—11. Arteries of excreting lacrymal organs—12. Veins—13. Nerves—branch from infratrochlearis—musculus sacci probably supplied by portio dura.

Functions.—The tears and mucus being partly dissolved in the air, and partly absorbed by the conjunctiva, the rest is taken up by puncta, and conveyed into lower meatus of nostril, through the excreting lacrymal passages—this effected partly by mechanical, and partly by vital, powers, and goes on during sleep.

Comparative Anatomy.—1. In most mammalia, no lacrymal groove —foramen in os unguis in some—lacrymal bone, or os unguis, continued down the face in horse and some other mammalia—2. Puncta on inside of lids in quadrupeds—3. Nasal duct very long and thin in sheep, opening near external orifice of nostril—4. Subpalpebral gland, suborbital or lacrymary sinus of deer, sheep, &c., called *larmier* by the French, not a lacrymal organ—5. Two long processes of lacrymal bone in birds—opening of nasal ducts by one aperture in palate—6. Lacrymal capsule of serpents, opening by lacrymal canal, into intermaxillary sinus, and thence into mouth.

Diseases.—1. Injuries of puncta and lacrymal canals—2. Injuries of lacrymal sac—3. Injuries of nasal duct—4. Acute dacryocystitis, or inflammation of excreting lacrymal organs—5. Chronic dacryocystitis—its 5 stages—6. Fistula of lacrymal sac—7. Caries of bones around lacrymal sac and nasal duct—8. Relaxation of lacrymal sac. —9. Mucocele of lacrymal sac—10. Relaxation of puncta and lacrymal canals—11. Eversion of puncta—12. Obstruction of puncta and lacrymal canals—13. Obstruction of nasal duct—14. Dacryoliths or lacrymal calculi, in excreting lacrymal passages—15. Polypus of lacrymal sac—16. Exostosis of nasal duct.

SECTION VI.—ORBITAL AREOLAR AND ADIPOSE TISSUE—OCULAR CAPSULE—MUSCLES OF EYEBALL.

Structure.—1. Subconjunctival fascia—2. Ocular capsule—six openings in it for passage of muscles—3. Orbital areolar and adipose tissue—4. Obliquus inferior—5. Obliquus superior—its pully—6. Four recti—levator, depressor, adductor, abductor—7. Tunica tendinea—its insertion into sclerotica—8. Muscular arteries and veins—9. Muscular nerves—3d or motor oculi, 4th or trochlearis, 6th or abducens.

Functions—1. Yielding cushion, formed by fat, from contact with which eyeball excluded by capsule—Eyeball and muscles supported by capsule—2. Centre of motion of eyeball—3. Actions of recti—elevation, depression, adduction, abduction, circumduction of eyeball—lateral movement of eyes by adductor of one with abductor of other—such associated actions depending on constitution of motor nerves—recti, antagonists to each other, and antagonized by obliqui—4. Obliqui roll eyeball on its antero-posterior axis—association of

obliquus superior of one eye with obliquus inferior of opposite eye, in lateral motions of the head—obliquus inferior rolls eyeball upwards and inwards, superior downwards and outwards—consentaneous movements of eyeball and eyelids—eyes turned and fixed by muscles in any given direction, so that vertex of retina may receive tbe image of objects, to be seen distinctly—supposed effect of recti and of obliqui in accommodating eye to distances.

Comparative Anatomy.—1. Obliquus inferior inserted close behind cornea in ruminantia—2. Suspensorius or retractor oculi of quadrupeds —receives a branch from 6th nerve—3. Want of trochlea in birds, reptiles and fishes—4. Stalk supporting eye in cartilaginous fishes.

SECTION VII.—DISEASES OF THE OCULAR CAPSULE, AND OF THE AREOLAR AND ADIPOSE TISSUES OF THE ORBIT.

1. Injuries of orbital areolar tissue—presence of foreign bodies— 2. Effusion of blood into orbital areolar tissue—3. Phlegmonous inflammation of orbital areolar tissue—orbital abscess—4. Inflammation of ocular capsnle—5. Exophthalmos, or protrusion of eye from orbit— simple—anæmic—the latter generally attended by enlarged thyroid— 6. Protrusion of orbital adipose substance—7. Intraorbital tumours— solid—encysted—osseous—8. Malignant diseases in orbit—scirrhus— fungus hæmatodes—melanosis—9. Intraorbital aneurisms—aneurism of ophthalmic artery—aneurism by anastomosis—10. Varicosity of ophthalmic veins.

SECTION VIII. — DISEASES OF THE MUSCLES OF EYEBALL.

1. Injuries—2. Want of correspondence in their action—diplopia— monoblepsis—3. Palsy of muscles animated by 3d nerve—palsy of abductor—ophthalmoptosis.—4. Strabismus—symptoms—proximate cause—pathological anatomy—varieties—degrees—remote and exciting causes—treatment without surgical operation—treatment by excising a fold of conjunctiva—cure by myotomy—5. Luscitas— 6. Tetanus oculi—7. Oscillation of eyeball—8. Nystagmus.

PART SECOND.

THE EYEBALL.—*(Globus vel Bulbus Oculi).*

General form of human eyeball—axis equal to transverse diameter—right and left halves not symmetrical—size, absolute and apparent—circumstances affecting apparent size—weight—consists of five classes of parts—1st. Sensorial parts, *viz.* ocular portion of *optic nerve*, and its expansion, the *retina*—2d. Dioptric parts, refractive media, or lenses, *viz. vitreous, crystalline*, and *aqueous humours*, and *cornea*—3d. Consolidative tunic, formed by *sclerotica* and *cornea*—4th. Diaphragm or stop, which also acts as a photometer or measurer of light admitted into the eye—the *iris*—5th. Absorber of light admitted—the *choroid* and its *epithelium.*

SECTION I.—CONSOLIDATIVE TUNIC.

Structure.—1. Sclerotica—continuous with duro-matral sheath of optic nerve—diameter of sclerotic sphere $\frac{1}{2}\frac{9}{0}$ inch—fibrous structure of sclerotica—thickness, decreasing from behind forwards—strengthened in front by tendons of recti—external and internal surfaces—their relations—is perforated by bloodvessels and nerves—circular adhesion at anterior edge to choroid by ciliary ligament—aperture for entrance of optic nerve—aperture for framing in of cornea—annular depression at junction of sclerotica and cornea—scanty vascularity of sclerotica—general account of its pathology—liability to rheumatic inflammation—thickened in some cases—becomes abnormally adherent to choroid—then thinned and staphylomatous—2. Cornea—at once part of consolidative tunic and a lens—radius of convexity of cornea $\frac{1}{4}\frac{3}{0}$ inch—a non-vascular fibrous structure—yeilds chondrin on being boiled—perfectly transparent—form—thickness—proper fibrous substance constitutes greater part of thickness—covered anteriorly by epithelium, prolonged from conjunctiva—lined posteriorly by membrane of Descemet—proper substance of cornea, a continuation of sclerotica, only transparent—laminated—smooth anteriorly and bounded by thin structureless layer, called *anterior elastic lamina*—external investment of cornea, a stratified layer of tesselated epithelium, which

coagulates, and is easily removed, on exposing eye to action of boiling water—lining membrane of cornea, membrane of Descemet, sometimes called *posterior elastic lamina*, structureless, hard, clear like glass, retaining its transparency even after being exposed to action of boiling water, and, on being separated, rolling itself up towards proper substance of cornea—forms part of aqueous cell—is invested on free surface by single layer of epitbelium—ends at its margin in a plexiform tissue, prolonged to iris, and called *ligamentum pectinatum* or *pillars of iris*—corneal tubes, as seen injected with mercury—sinus circularis iridis, between sclerotica, ciliary ligament, and cornea—pressure destroys transparency of cornea—general account of its patbology—loses lustre by inflammation—becomes covered by red vessels—abscess in proper substance—ulcerates—ulcer penetrates—membrane of Descemet protrudes—iris protrudes—opacities of various kinds—conical cornea—fatty degeneration.

Functions.—Sclerotica and cornea form a shell, for containing and supporting tbe other parts of eyeball—to tbe sclerotica six muscles attacbed for motions of eye—cornea, from its density and curvature, tbe principal agent in refraction.

SECTION II.—ABSORBER OF LIGHT.

Structure.—1. Choroidea—a membrane composed chiefly of blood-vessels and pigment—extent—surfaces—their relations—fine areolar tissue, with irregular pigment-cells, interposed between sclerotica and choroid, called *lamina fusca*—choroid thickened anteriorly, and presenting externally annulus albidus, annulus gangliformis, or ciliary muscle—ciliary nerves seen passing into it—on internal surface, corpus ciliare, divided into pars striata, and pars plicata, or ciliary processes, which are seen forming radiated circle round crystalline—attacbment of cboroid to ora serrata of retina, and to zonula Zinnii of byaloid—wbile larger arteries and veins occupy choroid externally, capillary plexus is placed on internal surface, forming *tunica Ruyschiana*—pathology of choroid—inflammatory effusions from inner surface—sub-choroid dropsy, with coarctation of retina—ossific deposition—2. Pigmentous membrane, or choroid epitbelium, of dark tobacco colour—separates in a sheet from choroid under water—its hexagonal nucelated corpuscles seen with microscope—more dense upon ciliary processes, but corpuscles less regular in form—is pro-

longed over posterior surface of iris—in albinoes, and in front of tapetum lucidum of brutes, the corpuscles exist, but are destitute of colouring matter.

Functions.—Analogous to black coating of inside of optical instruments—ciliary muscle, part of the apparatus for adjusting eye to vision of near objects—capillaries of choroid the chief source of nourishment of vitreous and crystalline bodies.

SECTION III.—DIAPHRAGM AND PHOTOMETER.

Structure.—Iris—a perforated disk, framed into choroid, and suspended in aqueous bumour—anterior and posterior surfaces—two rings seen on anterior surface, an external or ciliary, an internal or pupillary—whitish radiating striæ, sometimes mistaken for ciliary nerves, anastomosing at junction of external and internal rings—ciliary and pupillary edges of iris—place of pupil—iris plane, but, seen through cornea and aqueous bumour, often seems convex—iris thicker than choroid—internal surface, called *uvea*, formed by thick layer of pigmentous epithelium—plaited appearance of uvea—connection of iris with anterior edge of choroid and internal surface of cornea—proper substance of iris muscular, while its bloodvessels partake of erectile property—ring, surrounding pupil, thicker than the rest, a sphincter of pupil—other muscular fibres, radiating from ciliary edge, open pupil—extensive mobility of iris—facility of motion increased by support on all sides of aqueous humour—pathology of iris—palsy of sphincter—palsy of radiating muscular fibres—adhesive and eruptive inflammations—iridoncosis or staphyloma uveæ.

Functions.—Affords aperture for transmission of light—by excluding lateral pencils, obviates spherical aberration of lenses—measures and moderates quantity of light admitted into eye—aids in accommodating eye to distance of objects.

SECTION IV.—SENSORIAL PARTS.

Structure.—1. Optic nerve enters eyeball $\frac{1}{5}$ inch to nasal side of axis—neurilemmata of nervous fasciculi ceasing, nerve contracts, and loses its white colour, its fibres becoming gray and transparent as it

passes through sclerotica and choroid—porus opticus, canal for artery and veins—lamina cribrosa of sclerotica—papilla conica within eye, a punctum cæcum, being comparatively insensible to light—Mariotte's experiment.

2. Retina, or ἀμφιβληστροειδὴς, from ἀμφιβλήστρον, *net*, and εἶδος *form*, on account of its resemblance in form to a net—extent—thickness—transparent during life—terminates by a serrated edge, *ora serrata*, at posterior margin of corpus ciliare, 2¾ lines from circumference of crystalline—external and internal surfaces—their relations—central fold, seen on dissection—fenestra centralis, surrounded by limbus luteus, in vertex of retina—retina commonly described as consisting of a medullary or nervous lamina, covered on convex surface by Jacob's membrane, and supported, next vitreous humour, by cellulo-vascular lamina—retina displayed under water, in Jacob's method—As shewn microscopically, retina consists of four layers, *viz.* 1. Stratum bacillosum, or Jacob's membrane, consisting of a mosaic of cones, surrounded by rods, resting perpendicularly on the following layer—2. Stratum granulosum, consisting of double layer of highly refractive nuclear-like corpuscles—3. Stratum gangliosum, formed by gray nervous matter, interspersed with caudate cells—4. Stratum fibrillosum, a plexiform continuation of the fibres of optic nerve—Concave surface of retina bounded by structureless membrana limitans, behind which branches of central artery and vein, whence the capillaries of the retina, which are distributed chiefly in stratum gangliosum—mutual connexion of elements of retina—fibres prolonged from rods and cones into other strata—limbus luteus does not extend to stratum bacillosum—at fenestra centralis, stratum granulosum wanting—this spot also avoided both by nervous fibres and by large branches of bloodvessels—pathology of the retina—subject to apoplexy—inflammation not attended by pain, and therefore apt to be overlooked—varicosity of bloodvessels—neuromata—melanosis punctata—atrophy.

Functions.—The retina is the only part of the eye which receives impressions from light—these are conveyed through the optic nerve to the brain.

SECTION V.—DIOPTRIC PARTS, REFRACTIVE MEDIA, OR LENSES.

Structure.—1. Vitreous body—transparent gelatiniform mass, occupying about $\frac{4}{5}$ths of globe of eye—form, a meniscus with concave surface, *fossa hyaloidea*, turned forward—covered by retina and choroid—inclosed in hyaloid membrane—supposed cellular, but structure unknown—vitreous fluid—its chemical composition—vitreous body in loose apposition with retina, but closely adherent to corpus ciliare—halo signatus, seen on separating choroid from vitreous body—zonula ciliaris or zonula Zinnii, a thickened continuation of hyaloid—its ciliary processes dovetailing with ciliary processes of choroid—becoming blended with capsule of crystalline, serves as its suspensory ligament—zonula lucida—orbiculus capsulo-ciliaris—Petitian canal, as seen inflated with air—its anterior wall formed by zonula Zinnii, its posterior passing into posterior wall of capsule of crystalline—canalis hyaloideus, which in fœtus allowed vessels to pass from central artery of retina through vitreous body to crystalline, obliterated in adults—patbology of vitreous body—disorganization and solution—atrophy—dropsy.

2. Crystalline body, consisting of lens and capsule—anterior hemispbere of capsule thicker tban posterior, structureless like membrane of Descemet, and like it elastic, so that on being divided, it rolls itself up towards lens—intracapsular cells of Werneck lining anterior hemisphere of capsule internally, as an epitbelium—after death, they expand and burst, forming the so-called *humor Morgagnii*—form of crystalline, an unequal double-convex lens—its diameter $\frac{7}{20}$ inch, its axis half tbis length—radius of convexity of anterior surface $\frac{13}{40}$ incb, that of posterior $\frac{9}{40}$ inch—its lamellated and tubulo-fibrous structure—tubulo-fibres microscopically examined—they are flat, six-sided, their average thickness $\frac{1}{3000}$ inch—their edges denticulated, especially in fishes—tubulo-fibres become narrower and denser towards nucleus of lens—stelliform figure formed by tubulo-fibres—triple divergence from each pole of lens—tubulo-fibres fused at each pole into granular substance—chemical composition of crystalline albuminous, or according to Mulder consisting of protein—crystalline an epidermic tissue—pathology of crystalline—anterior capsule, loaded

with red vessels—opacities of capsule and lens—diplochromatism—induration—softening—disorganization of lens—dislocation of lens.

3. Aqueous humour—contained in a cell, formed by heterogeneous structures, yet analogous to shut sac—boundaries—form, its axis measures rather more than $\frac{1}{10}$ inch—a meniscus—anterior and posterior chambers, communicating through pupil—delicate membrane, lining posterior chamber, seems result of change in pigment cells of ciliary processes and uvea after death—chemical composition of aqueous humour—is speedily regenerated—serous and yellow in diseased state.

4. Cornea—a segment of hollow sphere—[See Part II. Section I.]

Functions.—By refraction, to bring the pencils of light, which may be supposed to flow from every point of every object, to corresponding focal points on the retina, without iridescence, and at whatever distance the object may be placed.

Dimensions of some parts of human eye—proportions of humours—connexions of different structures of eyeball.

SECTION VI.—ARTERIES OF EYEBALL.

1. Arteria centralis retina—perforates optic nerve from below, along with corresponding vein—ramifies from papilla conica in four or five branches, covered only by membrana limitans of retina—capillary network, formed by these branches, seated partly in stratum fibrillosum, but chiefly in stratum gangliosum—experiment of Purkinje, by which spectrum may be seen of retinal arteries—in fœtus, branch of arteria centralis, called arteria humoris vitrei, passing through canalis hyaloideus to back of crystalline, is distributed to vascular sac of crystalline—[See Part II. Section X.]—2. Choroideal arteries, posterior or short ciliaries—thirty or forty in number, derived from ophthalmic artery and its branches—penetrate posterior part of sclerotica—give off twigs to sclerotica—having reached choroid, subdivide into branches, some of which pass into veins, others form capillary plexus on inner surface of choroid, the capillaries arising from the larger arteries in a stelliform manner, and constituting *tunica Ruyschiana*, while a third set pass on to corpus ciliare and iris—in pars striata these follow a flexuous parallel course—each ciliary process receives from twelve to twenty arteries, which anastomose freely together—3. Iridal, or long ciliary arteries—two in number—run, in equator of eyeball, be-

tween sclerotica and choroidea—their primary division about $\frac{3}{10}$ inch from ciliary edge of iris—their secondary division in ciliary muscle, forming great arterial circle of iris—branches radiating forward in iris—forming, by their anastomosis near pupil, little arterial circle—iridal arteries continued in fœtus into pupillary membrane, a part of vascular sac of crystalline, where they anastomose in arches, which, according to Cloquet, afterwards form by retraction the little arterial circle—iris derives arteries also from those of ciliary processes and from anterior ciliaries—4. Anterior ciliaries—about twelve in number—derived chiefly from superior and inferior muscular and lacrymal branches of ophthalmic—penetrate anterior part of sclerotica—partly join great arterial circle of iris—partly bend back into choroid.

SECTION VII.—VEINS OF EYEBALL.

1. Venæ comites of retina—much larger and more numerous than arteries—in brutes, commence with complete circle, *circulus venosus retinæ*, at ora serrata—2. Venæ comites of iris, accompanying long ciliary arteries—other veins of iris passing into vasa vorticosa of choroid, and into sinus circularis, which communicates with anterior ciliary veins—3. Venæ vorticosæ or vasa vorticosa of choroid—four principal trunks—effects of vorticose arrangement in opposing regurgitating impetus on the blood in coughing, sneezing, and the like.

Functions.—Non-vascularity of adult cornea, crystalline and vitreous body—nourishment of non-vascular parts—ultimate elements of all the tissues of the body extra-vascular—conditions for healthy nutrition—effects of unhealthy blood—of abnormal supply of blood.

SECTION VIII.—NERVES OF EYEBALL.

1. Formation of lenticular or ophthalmic ganglion, by nasal branch of ophthalmic division of 5th nerve, (*radix longior*,) and inferior branch of 3d nerve, (*radix brevior*)—situation of ganglion in orbit—receives filaments from cavernous ganglion of great sympathetic and from spheno-palatine ganglion—gives off 12 to 16 ciliary nerves, which, with 2 or 3 derived separately from nasal nerve, penetrate sclerotica—run forward, imbedded between sclerotica and choroid—enter annulus gangliformis or ciliary muscle, and there form a plexus, whence filaments proceed to the ciliary muscle, the cornea, and the

iris—spiral contractility of ciliary nerves—2. Cavernous ganglion of great sympathetic—sends branches to 6th, 3d, and 5th nerves—branches to ophthalmic ganglion—branches accompanying ophthalmic artery and its divisions.

Functions.—Effects of dividing 3d nerve—of dividing 5th nerve—of dividing great sympathetic, between superior and inferior cervical ganglion—of tying nervus vagus—contraction of pupil depends on stimulus communicated from retina, through brain, to 3d nerve—dilatation of pupil supposed to depend on stimulus communicated by branches of spinal nerves, passing through superior cervical ganglion of great sympathetic—common sensibility of eyeball dependent on 5th nerve—alleged insensibility of retina—influence of nervous system over nutrition and secretion in organ of vision.

SECTION IX.—COMPARATIVE ANATOMY OF EYEBALL.

1. General form and size of eyeball in mammalia, birds, reptiles, and fishes—eye very small in whale, compared with size of body—great size of eye in birds—proportions of axis and transverse diameter—axis longer than transverse diameter in bat—eye rudimentary in mole, and still more so in mus typhlus, being in the latter concealed under the skin—while many of the diversities in the structure of the eyes bear an evident relation to the medium in which animals seek their food, the distance at which they perceive it, the time of day or night in which they search for it, and the kind of food, dead or living, at rest or in motion, animal or vegetable, which they select, other peculiarities are at present altogether unexplained—2. Sclerotica—its great thickness in whale—its thinness behind insertion of recti in Greenland seal, so that by their contraction lens and cornea will be urged forwards, when animal plunges—divisible into three layers in birds—sclerotic circle of osseous scales, round cornea, in birds and reptiles—sclerotica cartilaginous in fishes—3. Proportion of cornea to sclerotica—form of cornea—in ruminantia—in goose—prominent in birds—flat in cetacea and fishes—retractor corneæ of birds, formed of striped muscular fibres—4. Choroid thick in carnivora—thin in herbivora—silver-coloured in whale—great development of ciliary processes in dog—canal of Fontana in mammalia and birds—*sinus venosus Hovii*—tapetum lucidum of some quadrupeds—covered by colourless pigmentary membrane or epithelium—causes eye to shine in compara-

tive, not in absolute, darkness—wanting in man, simiæ, lemur, bradypus, bat, rodentia, and birds—marsupium or pecten plicatum of birds and reptiles—four layers of choroid in fishes, *viz.* nacreous layer, tunica vasculosa, tunica Ruyschiana, and pigmentous layer—choroid gland of fishes, a rete mirabile, connected with tunica vasculosa—5. Form of pupil—in ruminantia—in cat-tribe—in owl—in goose—festoons of pigment depending from edge of pupil, in sheep and horse—distribution of ciliary nerves in birds—pupil languid in frog—generally motionless in fishes—upper edge palmated in ray—double cornea and pupil, but only single crystalline, in cobitis anableps—6. Linear termination of optic nerve in deer—funnel-shaped depression in some ruminantia—oblique perforation of sclerotic and choroid by optic nerve in birds—laminated and folded optic nerve, in birds, reptiles, and fishes—termination of nerve in birds—white nervous fibres in retina of rodentia—retina very extensive in man, simiæ, elephant, horse, and ruminantia, much less extensive in carnivora—folds of retina in birds—retina fissured in fishes—falciform process, extending from fissure, passing, in some instances, through a loop at back of iris, and ending in campanula Halleri, by lower edge of crystalline—four laminæ of retina in fishes—fenestra centralis and limbus luteus found only in man and simiæ—globules, colourless or of brilliant yellow or crimson tints, in connexion with rods and cones of Jacob's membrane, in fishes, reptiles, and birds—7. Man has more vitreous humour and a smaller lens, in proportion to the size of his eye, than any other animal—form of crystalline in mammalia, birds, reptiles, and fishes—lens soft in birds, hard in fishes—arrangement of tubulo-fibres in different classes of animals—denticulation of their edges best seen in fishes—8. In some cephalopodous mollusca, a transparent prolongation of integument continued from orbit over eye—cornea incomplete—no proper iris, choroid, nor aqueous humour—vitreous quite liquid—crystalline projects free through cornea, and in sepia loligo is exposed externally—sclerotica piereed by numerous foramina, through which enter, after intercrossing with each other, multidinous branches derived from optic ganglion—retina presents two layers, the inner one of a reddish brown colour, apt to be taken for pigment—pigment between the two layers of retina—crystalline, a sphere divided into two unequal segments, anterior smaller, posterior larger—betwixt them, a thin transparent membrane, continued from outer layer of retina—crystalline bears some resemblance thus to a Coddington lens.

SECTION X.—DEVELOPMENT OF THE ORGAN OF VISION.

1. Nucleated cell, the universal primitive form of every tissue—the fibres ultimately found in retina, sclerotica, cornea, choroid, iris, lens, &c. all arise from conversion of cells—the most important parts of the apparatus both of organic and of animal life developed upon same general plan in all vertebrata—nervous centres, with ear and eye, in early stages, present the same essential steps of development in fishes, reptiles, birds and mammalia—changes in incubated egg may be regarded as typical of what occurs in ova of all vertebrata—what occupies nine months in human embryo accomplished in twenty-one days in chick.

2. Separation of blastoderma or germinal membrane of ovum into two granular laminæ, an *internal*, *mucous*, or *organic*, and an *external*, *serous*, or *animal*—the former chiefly concerned in the formation of the nutritive apparatus, the latter in that of the vertebral column and nervous system—formation of intermediate or *vascular* lamina—laminæ dorsales—their formation, from serous layer, into a groove, and ultimately into a tube, called *medullary tube*, from which are developed spinal cord and brain—dilatation of anterior part of medullary tube into a series of vesicles, the rudiments of principal divisions of brain, *viz.* one, originating medulla oblongata and cerebellum; a second, the corpora quadrigemina; a third, the thalami and third ventricle; a fourth, the hemispheres of cerebrum—eye formed on each side by a a hollow pyriform diverticulum, the *ocular vesicle*, proceeding from third cerebral vesicle—both lined by layer of ganglionic corpuscles—connecting pedicle closes, and becomes optic nerve, while ganglionic lining of diverticulum is transformed into retina, the fundamental part of eyeball—optic nerve and retina, therefore, a production of cerebrum—Huschke's hypothesis of a primordial singleness of the organ of vision—although development of eye seems to take place from third cerebral vesicle, or that of third ventricle and thalami, optic nerves found ultimately to have their principal connection with second, in which optic ganglia originate.

3. Contradictory accounts, by Huschke and Gray, of the development of retina and lens; the former, ascribing the formation of these structures to an involution of integuments and ocular vesicle; the latter, denying such—development of eyeball proceeds partly from ocular

vesicle, partly from integuments—in chick, ocular vesicle arises before commencement of 2d day—at beginning of 3d day, formation of lens commences—ocular vesicle filled with vitreous humour—its front receives the lens, which is an epidermic tissue—fissure, continued from open front of vesicle to optic nerve, continues permanent in lowest vertebrata, and is sometimes seen in cases of coloboma even in man—layers of retina developed—choroid added, and iris formed at anterior edge of choroid—sclerotica and cornea applied from without, and partly from integuments—chiasma not formed in chick till 7th day—granular layer of retina seen in chick on 8th day—Jacob's membrane between 13th and 14th days—fibrous lamina on 18th day.

4. In human embryo, retina attached after a time round margin of crystalline—sclerotica and cornea, in 5th week, form consolidative tunic—cornea, towards 6th week, becomes distinguishable from sclerotica—not till 6th month, that cornea becomes transparent, and at the same time comparatively thinner, denser, and more prominent—sclerotica at first thin and translucent, allowing dark colour of choroid to shine through—protuberance at back of eyeball, corresponding to vertex of retina—crystalline lens large in proportion to other parts, nearly touching cornea—inclosed in its capsule, it is completely surrounded, in early stage, by a vascular sac, which for a time lines also the aqueous cell, not yet divided into two chambers—bloodvessels now seen penetrating into interior of eye—choroid distinctly visible in 2d month—pigment visible as early as 4th week—granular and coherent, so as to appear like a second membrane—ciliary ligament visible towards end of 3d month—ciliary body formed at a later period, and iris yet later, namely, about beginning of 4th month—it is at first narrow and colourless—gradually acquires breadth, forming its external or ciliary ring, which, intruding on vascular sac of the crystalline, sends vessels into it, and adheres to it in such a manner, that anterior portion of sac occupies the pupil, and constitutes *pupillary membrane*—where it extends from pupil to edge of crystalline, sac is called *capsulo-pupillary membrane*—remainder of sac invests crystalline body posteriorly, occupying fossa of hyaloid—interior or pupillary ring of iris now shoots forth beyond line of adhesion of external or ciliary ring to vascular sac, so that circle of adhesion of pupillary membrane to the iris is on anterior surface of latter, and the edge of pupil free—central artery of retina, having entered eyeball through optic nerve, divides into two sets of branches, one set, persistent, being sent to retina,

which closely embraces vitreous humour; while the other, *arteriæ hyaloideæ*, pass forward through vitreous body by canalis hyaloideus, to radiate from back of crystalline and envelope the whole of its vascular sac—arteries of sac communicate at edge of crystalline with those of zonula Zinnii, which form *circulus arteriosus Mascagnii*, and are derived from proper vessels of retina and from those of corpus ciliare—crystalline now retires from cornea—sac absorbed about beginning of 7th month—pupillary membrane breaks into shreds—its arteries retreat in arches, from centre towards periphery of pupil—anterior and posterior aqueous chambers communicate—arteriæ hyaloideæ become obliterated—in dissecting fœtal subjects, crystalline sometime comes away leaving anterior portion of vascular sac adbering to iris, tbus constituting a *pupillary membrane;* in otber cases, crystalline comes away entirely inclosed in vascular sac, and then no membrane is found in pupil—fibres of crystalline developed by coalescence of nucleated cells.

5. Accessory parts of eye appear subsequently to eyeball—muscles of eye not visible, in human embryo, till beginning of 4th month—recti seen before obliqui—up to 8th week, integuments pass smoothly over eyeball...conjunctiva then portioned off by formation of fold, which, in 9th week, surrounds anterior surface of eyeball like a ring—upper and lower parts of fold progressively enlarge until tbey meet each other over eyeball about 12th week—edges of eyelids adhere by extension of epidermis from one to other—this adhesion ceases towards latter months—edges of eyelids adherent for a week or two even after birth in carnivora and rodentia, and in these animals pupillary membrane entire as long as eyelids remain closed—tarsal cartilages appear in 5th month—cilia appear free towards 6th month—lacrymal gland recognizable in second half of 4th month—on first appearance of eyelids, lacrymal caruncle presents itself—diverticulum of conjunctiva sinks down to oro-nasal cavity as commencement of lacrymal sac and nasal duct—puncta project very much in 5th month—lacrymal apparatus in general, as also Meibomian follicles, proportionally much developed at an early period.

6. Rudimentary form of cranium a membranous sac, consisting of periosteum and dura mater—points of ossification developed between these membranes, whence osseous radii shoot out, and ultimately coalesce or are united by suture—base of cranium, witb exception of ethmoid bone, ossified at birth—ethmoid, the most tardy in its develop-

ment of all the bones of cranium—a deficiency at birth at posterior superior angle of lacrymal bone, between it and the frontal and ethmoid, and where a separate piece is sometimes formed—small separate bone sometimes formed also at lower part of lacrymal.

SECTION XI.—CHANGES IN THE ORGAN OF VISION DURING THE PROGRESS OF LIFE.

Eyeball proportionally large in child—disproportion still greater in fœtus—iris seems large in child, and, from eyelids being less developed than in adult, eyeball appears more spherical—sclerotica thinner and more of a blue colour in child—crimson hue sometimes reflected from fundus oculi in child—selerotica becomes whiter and denser, and cornea tougher, as age advances—areus senilis of cornea and crystalline—pupil becomes smaller and less lively, and iris appears closer to cornea—eyeball diminishes in size, and contains less fluid, especially less aqueous humour—cornea consequently flatter—pigment of choroid becomes pale, and at length almost colourless—crystalline becomes flatter on both surfaces—more and more dense, especially the nucleus—loses its clearness and colourlessness, becoming of an amber hue, and is often diplochromatic, so as to seem green, when viewed in the eye by reflected light—presbyopia occurs, the result of flattening of cornea and lens, and of diminished power in the muscular apparatus of accommodation—retina becomes thinner, tougher, and less acutely sensible—limbus luteus disappears—fat of orbit absorbed—folds of conjunctiva large—papillæ lacrymales prominent—skin of eyelids loose and superabundant—lacrymal fossa becomes shallow—orbit contracts.

SECTION XII.—CONGENITAL MALFORMATIONS, ARRESTS OF DEVELOPMENT, AND EFFECTS OF INTRA-UTERINE DISEASES OF THE ORGAN OF VISION.

1. Anophthalmos, absence of one or both eyes—2. Eyeball in cavity of cranium, and empty—3. Cyclopia, fusion of the two eyes—also of the two orbits, optic foramina, and optic nerves—4. Orbit wanting—5. Orbit abnormally small—deformed—deficient in some part of its parietes, and in this state sometimes giving rise to encephalocele—6. Microphthalmos, eye abnormally small—7. Megalophthal-

mos, eye abnormally large—congenital hydrophthalmia, aqueous, or general—8. Encysted tumour at temporal extremity of eye-brow—9. Eyelids absent—10. Eyebrows or eyelashes pye-bald—11. Coloboma palpebræ, a notch in one of eyelids, sometimes owing to gonorrbœa in one or both parents—12. Phimosis palpebrarum—13. Anchyloblepharon—14. Epicanthus, fold of skin projecting over inner angle of eye—15. Blepharoptosis, drooping of upper eyelid, complete or incomplete—16. Lagophtbalmos—17. Ectropium—18. Entropium—19. Trichiasis—20. Nævus of eyelid, conjunctiva, or caruncula lacrymalis—21. Conjunctival and subconjunctival tumours—22. Trichosis bulbi—23. Xeroma—24. No lacrymal gland—25. Lacrymal ducts wanting—26. Caruncula lacrymalis deficient—27. Stillicidium from want of puncta—28. Atresia canaliculorum—29. Punctum double—canaliculus double—30. Lacrymal sac protruding and opening outwards through skin—31. Fistula of lacrymal sac—32. No lacrymal sac—33. No osseous nasal duct—duct contracted—closed—opening not vertically but obliquely into nostril—34. Oscillation of eyeball—35. Strabismus, in some instances upwards—luscitas 36. Absence of one or more muscles of eyeball—37. Supernumerary muscles—muscles subdivided—38. Opacity more or less extensive of cornea—39. Staphyloma corneæ et iridis—40. Cornea wanting—41. Conical cornea—42. Globose cornea—43. Cornea abnormally flat, small—44. Astigmatism—curvatures of cornea unsymmetrical—45. Irideremia, iris partially or totally wanting—ciliary ring imperfectly developed, pupillary ring not at all—46. Coloboma iridis or cleft iris—often with microphtbalmos—the cleft sometimes extending to choroid, retina and vitreous body—40. Imperforation of iris—48. Eccentric pupil—49. Pupil deformed—50. Pupillary membrane persistent in whole or in part—51. Whitish striae on surface of iris, imitating forms of letters, as in Edward Woods—52. Maculæ iridis—53. Discrepantia colorum iridum—54. Pupil abnormally small, or large—55. More pupils than one, probably lacerations of iris, consequent to intra-uterine inflammation—56. Korestenoma, wart-like tumour of iris, sometimes with hairs growing from it—57. Synechia anterior vel posterior—58. Corpus ciliare wanting—59. Albinism, want of colouring matter in pigment—cell—60. Choroid wanting—61. Lens wanting—small—its development arrested—62. Oscillation of iris and lens—63. Cataract, lenticular, capsular, capsulo-lenticular, central, pyramidal—simple, or complicated with smallness of lens, amaurosis, micro-

ophthalmos, &c.—65. Asthenopia—66. Night-blindness—67. Neuroma of 5th nerve—68. Amaurosis—simple, or combined with oscillation of eyes, epilepsy, deficient brain, idiocy, hydrocephalus, &c. —sometimes with lively pupils—69. Retina wanting—70. No optic nerve—71. No chiasma—72. No foramen opticum.

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      a. Catarrhal. *b*. Leucorrhœal. *c*. Gonorrhœal. *d*. Traumatic.
    4. Conjunctivitis purulenta gonorrhoica.
  III. Conjunctivitis Eruptiva.
    1. Conjunctivitis pustulosa vel aphthosa.
    2. Conjunctivitis phlyctenulosa. (*Scrofulous ophthalmia.*)
    3. Conjunctivitis erysipelatosa.
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  I. Sclerotitis idiopathica. (*Rheumatic ophthalmia.*)
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III. Corneitis.
  1. Corneitis idiopathica.
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3. Corneitis postvariolosa. (*Variolous ophthalmia.*)
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PART THIRD.

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divided into two classes, *viz.* those which can and those which cannot be turned towards a common visual axis—the former supplied by optic nerve of same side, and the latter by optic nerve of opposite side—Texture of optic nerve—its dura-matral sheath—its neurilemma —plexiform interlacement of fibres of optic nerve—nerve-tubules, although present in human optic nerve, not to be discerned in retina —retina contains all the other structural elements of nervous system, *viz.* gray fibres, gray nervous matter similar to cineritious part of brain, caudate nucleated globules, and agglomerated granules, beside certain peculiar elements forming the stratum bacillosum or Jacob's membrane—nerve-tubules of optic nerve lose their white substance as they perforate sclerotica, and appear no longer tubular and white, but solid and gray—are united into retina—Relation of optic nerves to fourth ventricle—to lateral ventricles—to third ventricle—to pineal gland—to pituitary gland and infundibulum—to third nerve— Relation of optic nerves to bloodvessels—to internal carotid by side of sella turcica—to circle of Willis—to ophthalmic artery—to ophthalmic veins—to cavernous sinus—to other venous sinuses of dura mater.

Functions.—Effects of dividing optic nerve, close to orbit—behind chiasma—longitudinally through chiasma—Effects, on organ of vision, of dividing fifth nerve—of dividing third nerve—Effects of the destruction of one eye on the brain—Effects of dividing great sympathetic—Effects of destroying one or both optic lobes.

SECTION II.—COMPARATIVE ANATOMY OF OPTIC NERVES.

1. Relative size of nates and testes in different mammalia—the analogues of optic lobes of lower vertebrata, as is shown by development of these bodies—corpora quadrigemina not proportionate to size of optic nerves—large in mole—other purposes probably fulfilled by them in addition to their connection with vision—optic nerves of mammalia, —their decussation or chiasma—division of optic nerve in marmot into fasciculi, entering eyeball by a transverse chink—optic nerves rudimentary or deficient, when eyes rudimentary—commissure of optic nerves in mole.

2. Optic lobes hollow in birds, reptiles, and fishes—very large in birds of prey—laminated and interplicated chiasma, formed by inner fibres only—laminæ originate in tractus opticus—surface of nerves

increated hy longitudinal ribbon-like foldings, continued into retina—relation of optic nerve to pecten.

3. In ophidia and batrachia, nerves superposed—in sauria and chelonia, iutermixed—laminated portion of chiasma smaller than in birds.

4. Optic nerves of unequal size in pleuronectes—optic lohes also unequal—pair of tuhercles beneath optic lohes in fishes, whence optic nerves derive some filaments—no optic thalami—in osseous fishes, no intermingling of fibres at chiasma, nerves merely crossing each other and adhering hy means of connective tissue—in cartilaginous fishes, nerves intimately united in chiasma—folded nerve enclosed loosely in neurilemma—connection of optic nerve with falciform process in pike—in ammocetus, no optic nerve—in cyclopterus lumpus, optic nerves continued into each other, while point of union is connected to hrain merely by fine areolar tissue.

5. In invertehrata, no chiasma—decussation of filaments of individual optic nerves behind eyehall of cephalopoda—spherical bulb of optic nerve within compound eye of insects, giving off several thousand nervous filaments.

SECTION III.—GENERAL ACCOUNT OF AMAUROSIS.

1. Definition—2. Seats—retina, optic nerve, brain—*sensorial*, having its seat in the retina, optic nerve, or optic tubercle—*cerebral*, arising from disease in hemispheres, tumours attached to dura mater, &c.—*spinal*, springing from disease of 5th nerve—*ganglionic*, as when affections of digestive or generative system give rise to it—3. Causes—efficient—remote—always organic—complication of causes—4. Symptoms—objective and subjective—5. Forms, stages, and degrees—6. Diagnosis—7. Prognosis—8. Treatment.

SECTION IV.—CLASSIFICATION OF THE AMAUROSES, ACCORDING TO THE SEAT OF THEIR EFFICIENT CAUSES.

I. RETINA.

I. Pressure on Retina.

I. Pressure on convex surface of retina.

1. Sub-sclerotic dropsy.
2. Inflammation and thickening of choroid.
3. Sub-choroid dropsy, with coarcted retina.

II. Pressure on concave surface of retina.
1. Vitreous dropsy.
2. Displaced crystalline lens.
3. Varicosity of retinal blood-vessels.
4. Apoplexy of retina.

II. Structural changes in Retina.
1. Wounds of retina.
2. Concussion and laceration of retina.
3. Retinitis, acute and chronic.
4. Ramollissement of retina.
5. Hypertrophy of retina.
6. Atrophy of retina.
7. Neuromata of retina.
8. Melanosis punctata of retina.
9. Ossification of retina.

II. ORBITAL PORTION OF OPTIC NERVE.

I. Pressure on Optic Nerve.

I. Pressure by orbital diseases.
1. Hyperostosis or exostosis of orbit, or of sphenoid bone near foramen opticum.
2. Solid and encysted tumours in orbit.
3. Aneurism by anastomosis in orbit.

II. Pressure more immediately affecting optic nerve.
1. Aneurism of arteria centralis retinæ.
2. Tumours attached to, or contained within, envelopes of optic nerve.

II. Structural changes in Optic Nerve.
1. Wounds of optic nerve.
2. Rupture of optic nerve.
3. Inflammation of optic nerve.
4. Hypertrophy, and general or partial induration of optic nerve.
5. Atrophy of optic nerve.
6. Encephaloid tumour of optic nerve.
7. Melanosis of optic nerve.

III. ENCEPHALON, including optic nerves from their origin to the foramina optica.

I. Pressure on Encephalon.
1. Fractured and depressed cranium.

2. Hyperostosis or thickening of cranium.
3. Exostosis of inner table of cranium.
4. Fungous, osseous, and other tumours of dura mater.
5. Congestion of encephalic blood-vessels.
6. Apoplexy, from encephalic hæmorrhagy, &c.
7. Aneurism of encephalic arteries.
8. Enlarged pituitary gland.

II. Structural changes in Encephalon.

1. Injuries of encephalon, in wounds through orbit, fractures of cranium with depression, gun-shot wounds, &c.
2. Wounds of optic nerve, within cranium.
3. Rupture of chiasma by *contre-coup*.
4. Concussion and laceration of brain.
5. Inflammation of membranes of brain, producing adhesions, thickening, depositions of serum, lymph, &c.
6. Inflammation of chiasma.
7. Inflammation of brain.
8. Abscess in brain.
9. Ramollissement of brain.
10. Induration or scirrhus of brain.
11. Hypertrophy of brain.
12. Atrophy of brain.
13. Hydrocephalus, superficial or ventricular.
14. Enlarged pineal gland.
15. Scrofulous tubercles in brain.
16. Encysted tumours in brain.
17. Cartilaginous, osseous, and other tumours in brain; encephaloid cancer, melanosis, &c.

SECTION V.—COMPLICATIONS OF AMAUROSIS.

1. Puerperal convulsions—2. Syncope—3. Epilepsy—4. Hysteria—5. Disease of spinal cord—6. Hallucinations, as in delirium tremens—7. Mania.

SECTION VI.—EXCITING CAUSES OF CONGESTION OR INFLAMMATION OF THE NERVOUS OPTIC APPARATUS, AND THEREBY OF AMAUROSIS.

1. Intense light—2. Stroke of lightning—3. Over-exercise of sight—4. Irritation from teething, worms, disordered bowels, &c.—as in the inflammation of the brain in children, called acute hydrocephalus—5. Febrile diseases; as continued fever, scarlatina, measles, &c.—6. Passions of the mind; as, rage, grief, fear, &c.—7. Mental fatigue and anxiety—8. Insolation, or *coup de soleil*—9. Suppressed evacuations; as, of the menses, hæmorrhoids, milk, mucus of Schneiderian membrane, purulent matter of ulcers, &c.—10. Suppressed eruptions, acute or chronic—11. Cold, and suppressed perspiration—12. Narcotic and other poisons—13. Disorders of digestive organs, acute or chronic—14. Albuminuria, or Bright's disease of the kidney—15. Continued loss of any of the fluids of the body; as, in scorbutus, diabetes, protracted suckling, masturbation, &c.—16. Affections of the 5th nerve; as irritation, wounds, and morbid changes within cranium.

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1. From apoplexy of retina—2. From aneurism of arteria centralis retinæ—3. From tumours attached to, or contained within, the envelopes of optic nerve—4. From structural changes in optic nerves—5. From fractured cranium with depression, or from sanguineous extravasation in consequence of injury—6. From morbid changes in membranes or bones of cranium—7. From cerebral congestion—8. From apoplexy, sanguineous or serous—9. From aneurism of encephalic arteries—10. From enlarged pituitary gland—11. From concussion or other injury of the head—12. From congestion or inflammation of the nervous optic apparatus, brought on by exposure to intense light or by over-exercise of sight—13. From the same, excited by worms in the intestines—14. From suppression of the menses, or from pregnancy—15. From suppressed purulent discharge—16. From suppressed perspiration—17. From poisons—18. From acute or chronic disorders of the digestive organs—19. From continued loss of the fluids of the body—20. From albuminuria—21. From irritation of branches of the fifth nerve—22. From hydrocephalus—23. From scarlatina—24. From morbid formations in brain—25. Congenital amaurosis—26. Night-blindness—27. Day-blindness—28. Hemiopia.

APPENDICES.

APPENDIX I.—ENTOZOA IN THE ORGAN OF VISION.

1. Echinococcus hominis, in areolar tissue of orbit—2. Cysticercus telæ cellulosæ, in areolar tissue of eyelids, under conjunctiva, in cornea, in anterior chamber, in contact with retina—3. Filaria Medinensis, under conjunctiva—4. Filaria oculi humani, in crystalline—5.—Monostoma oculi humani, in crystalline—6. Distoma oculi humani, in crystalline.

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II. Subjective Exploration—Physiological Signs—Pain, its seat and character—impairment or loss of common sensibility—intolerance of light, or photophobia—moistness of eye—state of vision—power of adjustment—effect of concave or convex glasses--visual pseudo-sensations —*phosphène*, or production of lucid spectrum by pressure on eyeball —condition of other senses—condition of mental functions—state of general health—history of previous diseases.

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of the eye—14. Means of preservation from epidemic and contagious diseases of the eye—15. Care of the eyes in febrile diseases, and during convalescence—small-pox—influenza—16. Use and abuse of applications to the eyes in health—cold—hot—salves—lotions—17. Care of weak eyes—of eyes threatened with strabismus—18. Choice of spectacles—concave—convex—use and abuse of spectacles—preservers—single glass—double glasses—change of glasses—reading glass—kinds of frames—qualities of glass—pebbles—19. Shades for the eyes—coloured glasses—neutral-tinted—snow-spectacles—railway shades—shades for light-house-keepers.

APPENDIX V.—MEDICAL JURISPRUDENCE AND POLICE APPLIED TO THE EYE.

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APPENDIX VI.—LITERATURE OF OPHTHALMOLOGY.

No complete ophthalmological bibliography yet attempted, in consequence of the vast number of treatises and communications which

have appeared on the anatomy, physiology and pathology of the eye—meantime, advantage may be derived from what is contained in the following works :—

For the anatomy.

Rosenmüller, Partium Externarum Oculi Humani Descriptio Anatomica. Lipsiæ, 1797. pp. xiii—xlvii.

Bibliographie Splanchnologique, prefixed to the Traité de Splanchnologie et des Organes des Sens, par E. Huschke. Traduit par Jourdan. Paris, 1845. pp. xxxix—xlvi.

Kölliker's Manual of Human Histology. Sydenham Society's Edition. London, 1854. Vol. II, pp. 401, 402.

For the pathology.

Beer's Repertorium aller zu Ende des Jahres 1797 erschienenen Schriften über die Augenkrankheiten. 3 Theile. Wien, 1799.

Andreæ's Grundriss der gesammten Augenheilkunde. Erster Theil. Leipzig, 1846. pp. 5—124. Contains no fewer than 2206 titles of books and communications on eye-diseases.

For ophthalmology in general.

Chelius' Handbuch der Augenheilkunde. Erster Band. Stuttgart, 1843. pp. xiii—xx.

Himly's Krankheiten und Missbildungen des menschlichen Auges, und deren Heilung. Erster Theil. Berlin, 1843. pp. 6—15.

The End.

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